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Effects of global warming and pollutants on marine copepods across space and time

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Global warming and pollution are two major threats to global biodiversity, but it remains relatively unknown how these stressors interact synergistically on marine copepods across space and time. We addressed this through: (i) investigation of vulnerability of marine copepods from arctic to tropical ecosystems to global warming, heat waves and pollution and (ii) incorporating the evolution of thermal adaptation in shaping the vulnerability of marine copepods to contaminants. First of all, we investigated the combined effects of global warming and contaminants (e.g. polycyclic aromatic hydrocarbons - PAHs) on both thermal generalist and specialist copepods from arctic to tropical ecosystems (Greenland, Norway, Denmark and Vietnam) in order to generate a comprehensive understanding of their vulnerability to different scenarios of stressor levels. To fundamentally advance the mechanistic understanding of the role of thermal adaptation, we are exposing a fast growing tropical copepod to a simulated scenario of global warming for 10, 50 and 100+ generations and tracking the fitness-related traits in relating to the changes in physiology (e.g. respiration, heat shock proteins) and the gut microbiomes. We found that global warming had stronger negative effects on highly thermally adapted copepods such as arctic species while wide distribution species e.g. *Acartia tonsa* can deal well with the temperature increase. Exposure to PAH pyrene at the concentration of 100 nM or higher resulted in higher mortality, reduced fecal pellet and egg production of copepods; this pattern was less strong in arctic copepod such as *Calanus glacialis* than other copepods species. Our studies emphasizes the need to put more effort on studying key species such as marine copepods in highly thermally extreme environments like the Arctic and tropical marine ecosystems.

Female copepod *Calanus finmarchicus* (photo credit: Khuong V. Dinh)